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THE CURRENT STATE OF CZECHOSLOVAK  
AVIATION AND SPACE MEDICINE

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## FOREWORD

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### THE CURRENT STATE OF CZECHOSLOVAK AVIATION AND SPACE MEDICINE

Following is the translation of an article entitled "Soucasny Stav v Leteckem A Kosmickem Lekarstvi" by Vladimir Malcik in Casopis Lekaru Ceskych (Czech. Medical Journal) Vol ACIV, No 45, Prague, 4 Nov 1960, pp 1405-1409.

Since time immemorial man has been longing for a conquest of the air. This desire is expressed in the fable about Icarus. Many enthusiasts attempted to solve this problem, but a partial success was first noted in the 18th century. On the 19th of September 1783, a balloon carrying a group of "passengers" - a ram, a rooster, and a duck for the first time rose to the air. First human flight (Pilatre de Rosier) was realized two months later, on the 21st of November 1783.

In 1862 Glaisher and Maxwell reached the height of 7000 meters in a balloon filled with hydrogen. During this flight "altitude sickness" was observed for the first time. In 1785 Tissandier, Sivel and Croce Spinelli undertook a tragic flight which two of them did not survive. The balloon reached the height of 8600 metres, and Sivel and Croce Spinelli died of anoxia, and Tissandier fell unconscious. This flight gave impetus to an intensive study of "altitude sickness".

A complex of problems which laid the foundations of aviation medicine later arose with the invention of a heavier than air aircraft.

The first airplane was built by A. F. Mozhayskiy. It went up on the 20th of July 1882 and was piloted by Y. N. Golubev.

It was in 1903 that aviation acquired a greater significance by the use of the internal combustion engine in an airplane, introduced by brothers O. and W. Wright.

Development then proceeded rapidly and World War One airplanes could be used successfully for military purposes. The development of airplanes in the period between the two World Wars became even more intensive and the air force came to be one of the most important weapons in World War Two.

At the same time a great expansion was noted even in civil aviation, and year after year the airplane became a more and more desirable means of transportation.

In the period following World War Two, a new expansion of aviation began and new types of engines were being constructed. The piston engine was replaced by turbo-prop engine and jet engine, and new areas of knowledge were made accessible to mankind. Brilliant achievements of Soviet and American technology make it possible to leave the troposphere and the lower parts of stratosphere and enable the study of strata far beyond the limits of the atmosphere.

A new branch of aviation, astronautics, which is a further step in its evolution, is coming into existence. Development in this direction was stimulated not only by military considerations but as a result of a great expansion of human thought and endeavor to attain knowledge of the unknown. The origin of rockets, Earth satellites and space ships is logical. It follows from the development of technology and will produce a large amount of information and affect the growth of a number of scientific disciplines.

From the very beginning of aviation the physiological and pathological problems relating to flight have aroused the interest of both flyers and physicians.

The spiritual father of aviation medicine is considered to be Paul Bert, who by his experimental work described in the book "La Pression Barometrique" proved the correctness of Jourdanet's theory of the cause of "mountain sickness" and "altitude sickness", which he saw in anoxemia.

Physicians began to participate in the development of aviation more widely about the year 1911, later on during the World War I, and after the war. It was noted that manpower in the aviation services was being greatly reduced by numerous crashes. It was established that in 90% of the cases the crash was due to improper action of the pilot. A well-trained and experienced flyer is of great value to a country, first of all as a human being and because his training is expensive and of long duration. Consequently, in countries with an advanced aviation, research laboratories were founded for the study of physiology, pathology and hygiene and for acquiring experience which could be used for the selection of flyers and maintaining their capacities. These institutions brought into being a new branch of medical activity, aviation medicine. This branch comprises all problems of aviation for the solution of which cooperation of a physician is necessary.

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Also in this country the aviation administration displayed extraordinary interest in aviation medicine right after World War One. It established in Prague a military technical aviation institute with a department of health, the director of which was Major General Dr. Dominik Capek. The activities of the institute developed until World War Two when they were interrupted by the Nazi occupation. After the liberation of Czechoslovakia the activities of the institute were resumed. With Major General Dr. Dominik Capek leaving active military service, and by virtue of his further pedagogic and scientific activities in the Faculty of General Medicine of Charles University in Prague, two aviation medicine institutes have been established in the CSR: (1) Vedecko-vyzkumna Laboratori Letecké Fyziologie (Aviation Physiology Scientific Research Laboratory) as a branch of the Faculty of General Medicine of Charles University, Dr. Dominik Capek, director; (2) Ustav Leteckého Zdravotnictví (Institute of Aviation Medicine) subordinated to the MNO (Ministerstvo Narodni Obrany -- Ministry of National Defense), which is a military institute. It has a substantial number of physicians educated in various fields of medicine and acquainted with the problems of aviation medicine. These physicians are divided into two sections, the therapeutico-preventive and the scientific research section.

Furthermore, in January 1960 the Komise Leteckeho a Kosmickeho Lekarstvi Pri Fyziologicke Sekci Cs. Lekarske Spolecnosti J. Ev. Purkyne (Commission For Aviation and Space Medicine of the Physiological Section of the J. Ev. Purkyne Czechoslovak Medical Association) was established in the CSR. The most important of its statutes are as follows: a) The association unites members of the section working in a particular, narrowly specialized field; b) It acts as an advisory council of the section's committee for solution of problems within its narrowly specialized field; c) It watches over the quality of its field, looks after its development and progress and submits to the section's committee initial suggestions to the above effects; d) It carries out tasks in the respective discipline of science with which it was charged by the committee of the main section; e) The board of commissioners has three or, at most, five members of the commission, of whom one is member of the main section committee; f) The board of commissioners is in office for two years; g) The board of commissioners meets as often as necessary but at least twice a year; h) The decisions of the board of commissioners come into effect

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only after discussions and approval by the main section committee; i) The financial settlement of the commission's expenses is a part of the main section budget.

The Commission for Aviation and Space Medicine has, up to date, 142 members in all theoretical and clinical fields, according to the applications received. Out of the members of the Commission, eight are university professors and eight are associate professors. Other members are workers in various important medical centers.

Judging by the members, it seems that the Commission represents a solid scientific basis which, by applying certain effort, can master on a broad base all the tasks that face the workers in the field of aviation and space medicine.

In the USSR there is, as in Czechoslovakia, an astronautical commission as a branch of the physiological association. It unites medical workers interested in the problems of aviation and space medicine. Furthermore, there are in the USSR three other astronautical institutions associating scientists of all fields with a relation to astronautics. Physicians in these institutions represent only a part of the workers and form within these institutions biological sections.

They are the following institutions:

- 1) The Astronautical Commission of the Academy of Sciences, which is a governing organ;
- 2) The Astronautical Society, which has five sections, one of which is biological;
- 3) Dobrovol'noye obshchestvo sodeystviya Armii, Aviatsii i Flota -- Voluntary Society for Cooperation with the Army, Air Force and Navy) Astronautical Section of the DOSAF which has the same structure as the Astronautical Society.

The situation in aviation medicine abroad is similar to that in the CSR. In various countries exist institutions of aviation medicine, mostly military, but sometimes also civil. Even various national associations of aviation and space medicine analogical to our Commission for Aviation and Cosmic Medicine are being formed or have been formed. In Europe, however, these institutions or associations have not yet formed an international organization of aviation medicine which would hold regular conventions, publish a central periodical dealing with problems of aviation medicine, and co-ordinate, plan and organize the scientific efforts of all national associations and institutions.

In America there is the Aerospace Medical Association, which performs such tasks. It convenes regularly and publishes its periodical, the title of which was the

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Journal of Aviation Medicine up to the middle of 1959. and later changed to Aero-space Medicine. The Aero-space Medical Association has two branches in Europe: the French and the Scandinavian. The French branch recently assumed the duty of holding conventions in Europe. The first congress took place in 1956 in Paris, the second in 1957 in Stockholm, the third in 1958 in Louvain, the fourth in 1959 in Rome, and the next will meet between August 30 and 2 September 1960 in London.

Some of the participants at the Louvain congress in May 1958 presented a proposal that at the next congress in Rome in 1959 a European federation of aviation and space medicine, or possibly a world-wide federation of aviation and space medicine which would include the American Aerospace Medical Association, be established.

The Rome congress did not clarify this question. It became apparent that there was no unity among the delegates and that opinions differed. Some of the delegates supported the formation of a world federation, others were only for a European federation, and still others upheld the preservation of the present state, that is, that of separate national associations.

The Italian delegation submitted two proposals of statutes for the European Federation (Association) of Aviation and Space Medicine at the Rome congress.

I should like to present some of the fundamental parts of the Italian proposal:

Section No 1: The European Association of Aviation and Space Medicine is being established. All associations specializing in the field of aviation medicine existing in Europe at the present time, or any which will be founded in any European country in the future are eligible for membership.

Section No 2: The purpose of the Association is

- a) to support and co-ordinate the study and research of aviation and space medicine in all European countries;
- b) to promote the knowledge of this branch of medical science in all European countries and to emphasize the great importance of the study of aviation medicine for the progress of medicine, biology and specialized fields;
- c) to co-operate with non-European associations.

For the purpose of fulfillment of the outlined objectives the following proposal was made:

1) to hold regular international aviation and space medicine congresses;

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- 2) to gather information and compile surveys of all achievements in Europe and in other parts of the world in the field of aviation and space medicine;
- 3) to spread this information by means of an international bulletin published fairly frequently.

Section No 3: The executive power of the European Association of Aviation and Space Medicine rests with a) the board of directors; b) the central committee. The board of directors is elected by the central committee. Each national association of aviation and space medicine sends two to three members to the central committee. The central committee elects its own board of directors. The president, vice-president and the secretary-general are elected for a term of two years; all other members of the board of directors for four years. The seat of the association is Rome. Applications for membership are approved by an absolute majority of votes. Cancellation of membership is not bound by any condition. The expulsion of members is decided by vote in the central committee. The voting is secret and an absolute majority is required.

A majority of delegates did not have appropriate credentials and were not entitled to discuss the proposals; therefore, the final discussion of this question was placed on the agenda of the next congress in London which will convene in the fall of 1960. This is roughly the present situation in the organization of aviation medicine.

For a more accurate picture of the situation in aeronautics it is necessary to present information on the organizational structure in non-medical fields. In the course of 1959 there was established in Czechoslovakia, by a decision of the central committee of the CSAV (Ceskoslovenska Akademie Ved -- Czechoslovak Academy of Sciences), an aeronautical commission which, from the point of view of organization and economy, is affiliated to the technical section of the CSAV. The chairman of the Astronautical Commission is Dr. Rudolf Pesek. This commission joins workers of fields having a close relation to aeronautics. It also has a biological group (consisting of four members), the chairman of which is Dr. Zdenek Servit. Dr. Servit forms a very useful connecting link between the Commission for Aviation and Space Medicine and the Astronautical Commission of the Technical Section of the CSAV.

Only the most important parts of the statutes of the Astronautical Commission of the Technical Section of the CSAV will be mentioned here.

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1. The Astronautical Commission has at least 25 members chosen from among distinguished Czechoslovak scientific workers active in the disciplines having a close relation to aeronautics.
2. For the solution of specified problems, the Commission shall appoint work teams, the members of which may be both members of the Commission and individuals from a wider circle of persons interested in the problems.
3. The Commission shall strive to co-ordinate the activities in the sphere of aeronautics.
4. The Commission shall work through the organs of the CSAV toward including the solution of problems of aeronautics in the plan of activities. It shall also see to it that a necessary number of workers be assigned to the tasks and that sufficient time and appropriate means be placed at their disposal.
5. The Commission shall propose that outstanding works from the field of aeronautics be rewarded or perhaps that contests with awards for the best solution be announced.
6. The Commission shall give an impetus toward calling scientific conferences, seminars or symposia and shall prepare their program or schedule.
7. The Commission shall support publication activity in all fields of aeronautics.
8. The Commission shall establish relations with similar scientific organizations abroad.

In September of 1959 the 10th Congress of the International Federation of Aeronautics took place in London. Czechoslovakia sent Dr. Rudolf Pesek as its delegate. At this congress the Astronautical Commission was accepted as member of the International Federation of Aeronautics with voting right as the representative of the CSR in this organization.

The president of the Astronautical Federation is Member of the Academy Sedov, of the USSR. The representative of the CSR is Dr. Rudolf Pesek.

The function of the International Federation of Aeronautics is the following: 1) To support and give impetus to the realization of peaceful flights into outer space; 2) to spread information on flights into outer space; 3) to encourage work on aeronautical problems through international and national institutions; 4) to hold international conventions; 5) to initiate action resulting in the establishing of an international research institute of aeronautics. The seat of the International Federation of Aeronautics is Baden in Switzerland.

One more institution is going to be separated from

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the International Federation of Astronautics, the International Astronautical Academy. At the present time it has a preparatory committee, a member of which is Dr. Rudolf Pesek of Czechoslovakia. The International Astronautical Academy will have five sections, one of which will be biological.

The end of 1959 brought a significant event for Czechoslovak astronautics. Czechoslovakia was accepted as member of the International Federation for the Study of Outer Space of the United Nations Organization in New York. This calls for Czechoslovakia to intensify and improve the quality of research activities in the field of astronautics.

This completes the brief survey of the organizational structure of aviation, space medicine and astronautical institutions in this country and abroad. In the following part of my report I should like to mention certain problems of aviation and space medicine.

The basis of aviation and space medicine is the study of physiology and pathology of flight. During flight the flyer finds himself in an environment which physiologically differs considerably from the environment in which man has constantly developed and from the conditions to which the human organism has adjusted itself.

Factors such as decrease of atmospheric pressure and partial oxygen pressure, cold, noise, vibration, radiation, centrifugal force, acceleration and imaginary perceptions are the origin of certain disturbances to which the organism responds by a specific reaction, which leads to stabilization in a new equilibrium. The adjustment ability of the organism has, however, certain limits. Going beyond these limits may result in serious damage or even death.

In aviation medicine we generally speak of two periods. The era of classical aviation medicine began about the year 1870 with the works of Paul Bert and has remained in existence until today. The second era is characterized by the transition to space medicine and the nascence of that to which we ourselves are witnesses at the present time.

Classical aviation medicine was conditional, during its birth and development, upon aircraft with a low vertical range and was limited to the solution of a rather small number of problems. Its problems can be defined as follows: 1) The mechanical effect of the decrease of atmospheric pressure effect on cavities of the body and desaturation aeropathy; 2) the influence of lack of oxygen on the entire organism and especially on the nervous sys-

tem; 3) the influence of noise and vibration; 4) the influence of positive and negative overloading; 5) the effect of cold and wind; 6) intoxication; 7) activity of the visual analyzer in unfavorable conditions (brightness, darkness, etc.), complex visual functions (depth perception, night vision, color determination); 8) kinetoses and functions of vestibular analyzers; 9) orientation in space and flight illusions; 10) psychology of flight; 11) formation of flying habits including change to new types of aircraft; 12) question of aviation accidents and aviation traumatology; 13) transfer of injured persons in aircraft and transportation of passengers; 14) means of rescue and physiology, pathology and traumatology; 15) flyer's nutrition; 16) hygiene of flying suits, temperature systems, etc.; 17) determination of flyer's efficiency and the related question of flyer's age; 18) chronic fatigue; 19) system of work and rest; 20) selection and methods of selection.

All the above problems of classical aviation medicine have been practically solved. In the present period of great expansion in technology, airplanes are being put into operation which enable flights to altitudes between 20,000 and 30,000 metres. A justified assumption prevails that within a very short time new vehicles will reach space. Aviation and space medicine must accommodate itself to the rapid development of technology and, to a certain degree, has to be slightly ahead of the technology.

In this respect classical medicine has become thematically very poor and, to master the tasks, a number of new problems have been added. In addition to these problems, which were not contained in the field of classical aviation medicine, space medicine calls for an extension and substantial supplementing of a whole number of partial requirements with which classical aviation medicine has been dealing. The two basic aspects of aviation medicine are preserved even in the new age, but they have changed qualitatively.

The first task consists in the selection of flyers using very efficient machines and the selection of astronauts. The difference between the two is merely quantitative.

The second task is protection of health and life of the crew in the conditions of their posts of duty. In space medicine another task arises, that of the determination of reactions to the conditions of flight in space, possibly in conditions of other planets. The research is being carried out by an entire staff of workers made up of specialists in individual fields, aviation physicians,

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psychologists and physiologists.

It was originally assumed that man with his abilities would not be able to work in a space ship. However, the Soviet and American experiments with animals in rockets, the data received from Layka in the Soviet Sputnik, the weightlessness experiments with men in jet planes, and the gravity experiments with men in centrifuges proved that a screened and trained individual is able to fulfill this task. On the basis of the above experiments a general astronaut type was laid out.

An astronaut must be a man of extraordinary intelligence and of high technical talent. He must be resistant against gravitation, weightlessness, and confinement, and it is necessary that he have a good orientation ability in space under all conditions. Very important is his motivation. The reason should not be his desire for publicity but an interest in discoveries and scientific enthusiasm. As for selection, it will be necessary to work out new methods of screening and a specific evaluation system.

It would be useful to develop automatic chemical methods of humoral reactions with a possibility of their transmission by radio so that the reactions of the subject could be followed on the ground at the time they are being produced. Even the second task, that of protection of the health and lives of the crew in conditions of their duty posts, requires the solution of a number of problems. Some of them have been already treated by classical aviation medicine, but at the present time their extension and substantial supplementation is necessary. The problems in question are as follows: 1) The effect of noise and vibration. Solution of this problem is becoming more urgent with the growing intensity of these stress factors. The noise of modern aircraft exceeds the intensity of 160 db, and in rockets it is considerably higher. Vibration is, next to noise and gravitation, the greatest medical problem in rockets. The effect of gravitation and protection against it has to be solved again due to the fact that a much higher and longer acceleration has to be taken into account. The psychology of the instrument panel is extended to psychology of the entire area, to psychology of contact, and briefly to questions of psychological comfort. The question of habit formation with respect to the conditions of the start, flight and return of the space ship has a special character. The problem of efficiency and the closely related problem of fatigue has to be solved, in contrast to the principles of classical aviation medicine, through a much wider application of

drugs. The problem of orientation in space and the problem of flight illusions are being essentially expanded. In this relation the occurrence of hallucinations, pseudohallucinations, etc. have to be taken into consideration. The physiology of vestibular analyzer undergoes a considerable amplification. A similar process is noted with hygienic problems of flying suits. The problem of nutrition comes to unusual areas.

A) Physiological Problems.

- 1) Problem of pressurized oxygen inhalation and compensation suits.
- 2) Change of atmospheric pressure and effect of minor hypoxias (up to 3 km).
- 3) Effect of vacuum.
- 4) Effect of weightless state of long duration.
- 5) Effect of gaseous environment: effect of oxygen and helium during a very long (several months up to several years) stay in artificial atmosphere, effect of ozone, chemical intoxication by CO<sub>2</sub>, and problem of biotoxins.
- 6) Effect of radiation, especially cosmic radiation; mechanism of injury, long-term effect of small doses; the best protection.
- 7) Change of periodicities: astronaut may be in total darkness, artificial daylight, or in a rapid succession of light and darkness.

B) Psychological problems.

- 1) Effect of solitude and isolation.
- 2) Effect of confinement.

C) Hygienic and technical problems.

- 1) Production and removal of water.
- 2) Production of oxygen: biological method (chlorella) and chemical method (peroxide of lithium).
- 3) Removal of waste.
- 4) Production of food: synthetic and biological.
- 5) Effect of cosmic radiation on drinking water, food, solidity of certain substances, etc.
- 6) System of sleep and rest, physical and mental work during flight in space.
- 7) Crash precautions (hibernation, etc., lowering of metabolism).
- 8) Traumatology during deceleration.
- 9) Occurrence of microorganisms in the upper strata of atmosphere.

This enumeration of problems that await solution is not and cannot be complete. I have mentioned only the most important questions.

From the above outline of problems it follows that in the solution of many of them neither space rockets nor satellites are necessary. They can be solved with those means that we have or can put at our disposal.

A proof that many problems of aviation and space medicine can be solved in our conditions is the submission of concrete themes from various stations.

Some of the themes received can be consolidated in order to form several thematic groups with common

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basic problems. Each thematic group is headed by a scientific leader of the problem, whose task it is to watch over the scholarly standard of the work, to co-ordinate the work of the group, and in co-operation with the board of commissioners to secure the necessities for the work of his group.

The following thematic groups were established:  
1) Noise and vibration. 2) Vestibular analyzer. 3) Radiation. 4) Nutrition. 5) Neurophysiology and psychology. 6) Microbiology. 7) Skin hygiene. 8) Effects of gravitation. 9) Basic physiological functions. 10) Determination of efficiency during flight.

In addition to the above themes, many workers submitted topics which by the character of the problems treated do not belong in any of the described groups. These topics will be handled separately at the respective stations, perhaps in co-operation with the respective workers of the Prague Institute of Aviation Medicine.

In order that the Commission for Aviation and Space Medicine may be successful, not only the enthusiasm of physicians but also the understanding and assistance of institutions and workers in other fields are necessary. We are counting, first of all, on the close co-operation of the Astronautical Commission of the Technical Section of the CSAV. Its president, Dr. Rudolf Pesek, is favorably inclined toward co-operation between the technical staff and the physicians, and he has informed the board of directors of our Commission that in space rockets which will be fired by Czechoslovak scientists in the near future on the territory of the Czechoslovak republic, certain space and weight will be reserved for experimental purposes by workers in aviation and space medicine.

It seems that the members of the Commission for Aviation and Space Medicine of the J. Ev. Purkyne Czechoslovak Medical Association have favorable working conditions in order that by means of the Astronautical Commission of the Technical Section of the CSAV their work might receive response in the work plans of the Central Committee of the CSAV. In this manner conditions for a possible co-operation on problems co-ordinated by the Academy of Sciences of the USSR would be established.